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May 7, 1999

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Ms. Magalie Roman Salas
Secretary
Federal Communications Commission
The Portals
445 12th St. S.W., Room TW-A325
Washington, D.C. 20554

Re: Written Ex Parte in CC Docket No. 98-56 and
CC Docket No. 98-121

Dear Ms. Salas:

On May 7, 1999, BellSouth sent the attached documents to Daniel Shiman in response to his request that we share a copy of all documents that we filed in the Louisiana Public Service Commission's proceeding LPSC Docket Number U-22252-C.

Pursuant to Section 1.1206(b)(1) of the Commission's rules, I am filing two copies of this notice and those documents for inclusion in the record of both dockets identified above.

Sincerely,

Kathleen B Levitz

Kathleen B. Levitz

Attachment

cc: Daniel Shiman (w/o attachment)
Jake Jennings (w/o attachment)

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May 7, 1999

Dr. Daniel Shiman
Policy and Program Planning Division
Common Carrier Bureau
Federal Communications Commission
445 12th Street, SW, Room 5-B155
Washington, D.C. 20554

Written Ex Parte in CC Docket No. 98-121 and CC Docket No. 98-56

Dear Dr. Shiman:

You had requested that BellSouth share with you copies of any document that BellSouth filed in the Louisiana Public Service Commission's proceeding LPSC Docket Number U-22252-C. Attached are copies of two documents, "Error Probabilities of the BST Adjusted Jackknife Test" and "Follow-on Statistical Analysis Of BellSouth Telecommunications, Inc. Performance Measure Data," that BellSouth filed in the Louisiana docket on April 15, 1999. If after reviewing these attachments you conclude that you need additional information, please call me at (202) 463-4113.

In compliance with Section 1.1206(b)(1) of the Commission's rules, I have filed with the Secretary of the Commission two copies of this written ex parte presentation for inclusion in the records of both CC Docket No. 98-56 and CC Docket No. 98-121.

Sincerely,

Kathleen B. Levitz

Attachment

cc: Jake Jennings

Error Probabilities of the BST Adjusted Jackknife Test

This note is the second of a set of discussions concerning the types of error that are present in hypothesis testing. Previously, we discussed the issue of balancing error probabilities. Here we are considering which estimate of the standard error of the test statistic is most appropriate. In other words, what is the correct denominator of the z test. We are using a set of simulations to explore this issue. Statistical theory assumes the net effect of correlations in the sample observations is zero for the LCUG modified z denominator. To the extent that the observations are not independent and the effect of the correlations does not balance out to zero, the denominator of the z-test should be increased. One way to look at this is that there are fewer separate pieces of information since there is overlap in the information conveyed by the observations, effectively reducing the sample size.

The BST adjusted jackknife z test uses the standard error that incorporates whatever variability exists in the data as a denominator. Whether data are correlated or not, statistical theory says that the jackknife method will capture the standard error that matches the numerator of the test statistic. If observations are independent, the LCUG modified z and the BST adjusted jackknife z results should be the same.

When the simulations are constructed so that all observation in a sample are independent, then

- the Type I and II error probabilities of the LCUG modified z statistic, calculated using the simulation, are equal to the values that statistical theory says they should be;
- the Type I and II error probabilities of the jackknife test statistic are statistically equivalent to those of the LCUG modified z statistic.

However, when simulations are constructed to allow for correlation between ILEC-CLEC from disaggregation cells within the same wire center, then

- the Type I and II error probabilities of the LCUG modified z statistics, calculated using the simulation, are <u>not</u> equal to the values that statistical theory says they should be under the assumption of independence;
- the Type I error probability of the jackknife test statistic is equivalent to the value that statistical theory says it should be;
- the Type II error probability of the jackknife test statistic is larger than it would be if the sample observation were independent since correlation effectively reduces the sample size.

Background

The performance measure data are not the result of a designed experiment but come from an observational study. The true means of the performance measure may differ across classes, defined by time, location, and type of service. The distribution of the CLEC observations over these classes may differ from the distribution of the BST observations. In this case, under the null hypothesis of no favoritism, the simple difference of means is a biased estimate. Adjustment by subclassification is a frequently used device for trying to reduce such bias. Weighted averages of the subclass means are compared, using the same weights for the ILEC cases and for the CLEC cases. We examined six test statistics that are based on the difference between the ILEC and CLEC averages, and compared their performance in terms of error probabilities.

All of the test statistics considered have the same basic form. Namely,

$$z = \frac{\bar{D}}{SE(\bar{D})},$$

where $\bar{D}$ is an estimate of the difference between the ILEC and CLEC means, and $SE(\bar{D})$ is the standard error of the estimate. We refer to these test statistics as

1. Modified z,
2. Adjusted Modified z 1,
3. Adjusted Modified z 2,
4. Jackknife,
5. Adjusted Jackknife 1, and
6. Adjusted Jackknife 2.

The exact formulas for each of these test statistics are given in the appendix. Test number 1 is a straight forward calculation of the LCUG statistics applied to the whole data set without any adjustments. Tests 2 and 3 are similar but use weighting adjustments to correct for bias in the numerator of the test statistic. The standard errors for these tests differ in the way that the variance of the data is estimated. Test 2 uses a weighted variance estimate, and 3 uses a weighted average of subclass variance estimates suggested by Dr. Mallows.

Tests 4 through 6 use a jackknife approach to estimate the numerator and denominator of the basic test statistic. Tests 5 and 6 have adjustment factors that make the test more sensitive to the situation where the ILEC variance is actually much smaller than the CLEC variance. The difference in the adjustment factor is analogous to the difference in the way the variances are estimated for tests 2 and 3.

Hypothesis tests are usually compared through their probabilities of erroneously accepting one of the two competing hypotheses. The possible errors are:

Type I error -- concluding favoritism exists when it in fact does not, and

Type II error -- concluding that there is no favoritism when in fact it there is.

Typically, the probability of a Type I error is held fixed, and this determines a critical value for the test. If the test statistic is more extreme than the critical value, then the null hypothesis of no favoritism on the part of the ILEC is rejected in favor of the alternative—ILEC favoritism exists. The probability of a Type II error depends on the specific form of the alternative hypothesis. It is not directly controlled, but it decreases as the sample size increases.

In our analysis, we chose -1.65 as the critical value so that the corresponding Type I error rate of the z test is about 5% when the samples are independent and identically distributed (iid) observations from a normal distribution. Given that

- the alternative level of disparity is defined by setting the CLEC mean equal to the ILEC mean plus 0.1 times the ILEC standard deviation in a comparison subclass (disaggregation cell), as suggested by Dr. Mallows,
- the CLEC sample size is, on average, 5% of the ILEC sample size, and
- the average sum of the ILEC and CLEC sample sizes is 29,120

then the Type II error rate will be around 5%.

Error Probabilities Simulation

We simulated the error probabilities of the tests by generating observations using a super population model. The detailed steps of the simulation are in the appendix. In general, repeated samples are drawn from the super population. Each sample is treated as if it is the finite population of interest and all the test statistics are calculated using the sample. For each test, the corresponding probability of rejecting the null hypothesis of parity is the proportion of time that the test values, calculated for all the repeated samples, fall below -1.65.

The general features of the super population are as follows. There are 240 wire centers in the population. Within each wire center, there are two subclasses, one with average mean around 0.75 and the other with mean about 3. The size of the subclass with smaller mean is generally larger than that of the subclass with larger mean. This was modeled after our observation of the real data; the two subclasses could be thought of as non-dispatched and dispatched orders. Within each wire center, the ILEC observations are from a multivariate normal distribution where the means of each subclass may differ, and the correlation between any two observation (within the wire center) is the same. We denote this correlation by ρ, and, for each wire center, it is drawn from a uniform distribution chosen to reflect the different correlation levels of the sample. Selecting ρ equal to zero draws independent observations. The ILEC observations are correlated within each subclass and wire center and they are independent across wire centers. The CLEC observations have the same correlation structure and are also from a multivariate normal distribution.

When simulating the Type I error rate, the ILEC and the CLEC samples are drawn from the same super population corresponding to the case where there is no discrimination between the ILEC and the CLEC observations. When simulating the Type II error rate, the ILEC and the CLEC samples are drawn from two super populations, which differ in their means, so that there is discrimination between the ILEC and the CLEC observations.

Table 1. Error Probability from 1000 Simulations when C=-1.65 and H_a: $\mu_{ILEC}-\mu_{CLEC}=0.1\sigma_{ILEC}$, Different Subclass Mean

Test Statistics	$\rho\in U(0.25,0.5)$		$\rho\in U(0.1,0.15)$		$\rho=0.0$	
	Type I	Type II	Type I	Type II	Type I	Type II
Modified Z	61%	4%	63%	1%	63%	0%
Adj. Modified Z 1	16%	14%	8%	6%	2%	2%
Adj. Modified Z 2	30%	7%	16%	3%	6%	5%
Jackknife	6%	36%	5%	10%	6%	6%
Adj. Jackknife 1	6%	36%	5%	10%	6%	6%
Adj. Jackknife 2	5%	36%	5%	11%	5%	5%

Our simulation results show that

1. If the observations are independent ($\rho = 0$, the last two columns of Table 1), the Jackknife test gives the same results as the adjusted modified z-test. That is, the Type I and Type II error probabilities of all three Jackknife tests are about 5%. Both of the adjusted modified z tests give the expected results, namely the probabilities for both Type I and Type II errors are about 5%. In other words, the Jackknife tests perform as well as the adjusted modified z tests when the independence assumption of the sample is satisfied.

2. If the ILEC-CLEC subclass mean differences are correlated within wire centers[1] the Type I error rate using the adjusted modified z tests is much larger than 5% but the probability of a Type I error using the Jackknife test is still 5%. This is to say that the Type I error probabilities of Jackknife tests are robust when the assumption that the effect of the correlations does not balance out to zero is violated. This result is similar to a situation we saw in the data analysis, where the adjusted modified z-test statistic was much more extreme than the Jackknife test statistic.

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[1] The estimate of the difference, $\vec{B}$ can be written as a linear combination of the form $\sum_{i=1}^{N} c_i d_i$ where the c_i are constants and the d_i is the ILEC - CLEC mean difference of subclass i. The variance of a linear combination such as this can be calculated as

$$\mathrm{Var}(\sum_i c_i d_i) = \sum_i c_i^2 \mathrm{Var}(d_i) + \sum_i \sum_{j\neq i} c_i c_j \mathrm{Cov}(d_i, d_j),$$

where $\mathrm{Cov}(d_i,d_j)$ is the covariance between the two quantities. The correlation of the two quantities is the covariance divided by the standard deviation of each quantity. An inherent assumption in the calculation of the denominator for the modified z statistic is that the covariance terms sum to zero. The jackknife methodology will capture this component of the variance when it is not zero, but the method does assume that there is no covariance contribution across wire centers. This is possible when there is correlation between subclass differences within a wire center, but no correlation between subclass differences from different wire centers.

3. Adjustment Cells are Necessary. The original LCUG test statistic, labeled here as the Modified Z Test, is included in the simulation study even though we believe it has been agreed that this test is not generally appropriate when applied to aggregate level data. In an observational study, bias is a major problem. The first row in Table 1 shows that if no attempt is made to adjust for confounding variables the bias can have a considerable effect. Without adjustment, the probability of rejecting the null hypothesis of parity, when in fact there is parity, is approximately 60% instead of the desired 5%.

4. The ratio of the jackknife variance to the variance assuming a simple random sample (the denominator of modified z 1 or 2) is a measure of a "clustering effect" in the data. If the actual ILEC and CLEC sample sizes are divided by this clustering measure, effective sample sizes for each are obtained. We are working on a methodology for using this information to determine how to balance the Type I and II error probabilities for a given month's performance measure data.

Appendix

Test Statistics

Notation:

n_1 = the number of BST cases

n_{1j} = the number of BST cases in subclass j

x_{1i} = the value of the performance measure for the i^{th} BST observation

$\bar{x}_1$ = the mean of the BST observations

$\bar{x}_{1j}$ = the mean of the BST observations in subclass j

$$\bar{x}_{1w} = \frac{1}{n_2}\sum_j n_{2j}\bar{x}_{1j} = \frac{\sum_j w_{1j}\sum_{i=1}^{n_{1j}} x_{1i}}{\sum_j w_{1j}n_{1j}} \quad \text{where } w_{1j} = \frac{n_{2j}}{n_{1j}}$$

$$s_1^2 = \frac{\sum_{i=1}^{n_1}(x_{1i} - \bar{x}_1)^2}{(n_1 - 1)}$$

$$s_{1w}^2 = \frac{\sum_j w_{1j}\sum_{i=1}^{n_{1j}}(x_{1i} - \bar{x}_{1w})^2}{\sum_j w_{1j}n_{1j} - 1}$$

$$c_1 = \frac{\sum_j w_{1j}^2 n_{1j}}{(\sum_j w_{1j}n_{1j})^2}$$

$$s_{1w2}^2 = \text{var}(\bar{x}_{1w} - \bar{x}_2) = \frac{\sum_j n_{2j}^1(w_{1j}^1 + 1)s_{1j1}^2 + n_{2j}^2(w_{1j}^2 + 1)s_{1j2}^2}{(n_2)^2} \quad \text{and}$$

s_{1j1}^2 and s_{1j2}^2 are the sample variances of ILEC observations in subclass 1 and 2 in wire center *j*.

Similar notation using the subscript 2 is used to denote the values for the CLEC cases, that is

n_2 = the number of CLEC cases, etc.

Test	Formula
Modified Z	$\dfrac{\bar{x}_1 - \bar{x}_2}{s_1\sqrt{\dfrac{1}{n_1}+\dfrac{1}{n_2}}}$
Adj. Modified Z 1	$\dfrac{\bar{x}_{1w} - \bar{x}_2}{s_{1w}\sqrt{c_1+\dfrac{1}{n_2}}}$
Adj. Modified Z 2	$\dfrac{\bar{x}_{1w} - \bar{x}_2}{s_{1w2}}$
Jackknife	$\dfrac{\bar{\bar{B}}}{\sqrt{v(\bar{\bar{B}})}}$
Adj. Jackknife 1	$\dfrac{\bar{\bar{B}}}{\sqrt{v(\bar{\bar{B}})}}\cdot\dfrac{\sqrt{c_1 s_{1w}^2+\dfrac{s_2^2}{n_2}}}{s_{1w}\sqrt{c_1+\dfrac{1}{n_2}}}$
Adj. Jackknife 2	$\dfrac{\bar{\bar{B}}}{\sqrt{v(\bar{\bar{B}})}}\cdot\sqrt{\dfrac{\sum_j[(w_{1j}^1)^2 n_{1j}^1 s_{1j1}^2+(w_{1j}^2)^2 n_{1j}^2 s_{1j2}^2]+\sum_j[n_{2j}^1 s_{2j1}^2+n_{2j}^2 s_{2j2}^2]}{\sum_j[n_{2j}^1(w_{1j}^1+1)s_{1j1}^2+n_{2j}^2(w_{1j}^2+1)s_{1j2}^2]}}$

Simulation Procedure

The simulation was carried out as follows.

1. Generate ILEC and CLEC sample sizes as follows. Draw n, the sum of ILEC and CLEC sizes, from a Poisson distribution with λ=29120. Split n into n_1 and n_2, the ILEC size and the CLEC size, by generating p from Uniform(0.025, 0.075), n_2 from Binomial(n_2, p) and n_1=n-n_2.

2. Generate ILEC and CLEC wire center sizes. For ILEC, draw the wire center sizes n_{1j}, j=1, …, 240, from a Multinomial (n_1, 240, p_s), where the probability vector p_s is generated from a Dirichelet distribution. Do the same thing to generate the CLEC wire center sizes n_{2j}, j=1, …,240. If one of the n_{2j} is 0, then the corresponding wire center is excluded from further analysis.

3. Generate the ILEC and CLEC observations from multivariate normal. For ILEC, draw the observations within each wire center from a multivariate normal with correlation matrix

$$
\begin{bmatrix}
1 & \rho & \Lambda & \rho & \rho \\
\rho & 1 & \Lambda & \rho & \rho \\
M & M & O & M & M \\
\rho & \rho & \Lambda & 1 & \rho \\
\rho & \rho & \Lambda & \rho & 1
\end{bmatrix}
$$

where ρ is from a Uniform(a, b) and can be chosen to reflect the different correlation level, including zero (independence), of the sample. The observations from different wire centers are independent of each other. Generate the CLEC sample using the similar method. The resulting draws are correlated if from the same wire center and independent if from different wire centers.

4. Split the observations within each wire center into two subclasses. For ILEC observations, draw the splitting probability p_{sp} from Uniform(0.65, 0.75); generate the first subclass size n_{1j}^{1} from Binomial(n_{1j}, p_{sp}), where n_{1j} is the j^{th} ILEC wire center size; and calculate the second subclass size n_{1j}^{2} using $n_{1j}^{2} = n_{1j} - n_{1j}^{1}$. The first n_{1j}^{1} draws of the ILEC observations in wire center j is the first subclass for wire center j and the rest is the second subclass. Split the CLEC sample using the similar method. n_{2j}^{1} and n_{2j}^{2} are the first and second subclass size of the CLEC for wire center j.
Since there are three possible outcomes of $n_{1j}^{1}, n_{2j}^{1}, n_{1j}^{2}$ and n_{2j}^{2} combinations, which subclass to use in the test statistics calculation depends upon the actual n_{1j}^{1} , n_{2j}^{1}, n_{1j}^{2} and n_{2j}^{2} values.
   a) If $n_{1j}^{1} > 0$, $n_{2j}^{1} > 0$, $n_{1j}^{2} > 0$ and $n_{2j}^{2} > 0$, then the observations in both subclasses of ILEC and CLEC are included in the calculation.
   b) If $n_{1j}^{1} > 0$, $n_{2j}^{1} > 0$ and either $n_{1j}^{2} = 0$ or $n_{2j}^{2} = 0$, then only the observations in the first subclass are used in the calculation.
   c) If either $n_{1j}^{1} = 0$ or $n_{2j}^{1} = 0$ and $n_{1j}^{2} > 0$ and $n_{2j}^{2} > 0$, then only the observations in the second subclass are included in the calculation.

   Denote the actual ILEC and CLEC sample size again as n_1 and n_2 for ease of notation.

5. Make the mean of the first subclass different from that of the second subclass. Draw a value from Uniform (0, 1.5) and add it to all the first subclass observations in all the wire centers. Generate a value from Uniform (1, 5) and add it to all the second subclass observations in all the wire centers.[2]

6. If simulating the type II error, we add $0.1s_1$ to all the CLEC observations, where

[2] We also simulated the case where the mean and variance of different wire centers are different from each other and the corresponding Type I and Type II error results are not much different from that of the case considered here. Tables 1 presents the results from the set up outlined here.

$$s_1^2 = \frac{\sum_j \left(\sum_{i=1}^{n_{1j}^1} (x_{1ij}^1 - \bar{x}_1)^2 + \sum_{i=1}^{n_{1j}^2} (x_{1ij}^2 - \bar{x}_1)^2\right)}{n_1 - 1}.$$

$x^1{}_{1ij}$ and $x^2{}_{1ij}$ are the value of ILEC observations in subclass 1 and 2 of the j^{th} wire center.

7. z statistics calculation. Calculate the Modified z test statistics

$$z = \frac{\bar{x}_1 - \bar{x}_2}{s_1\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}},$$

where $\bar{x}_1$ and $\bar{x}_2$ are the mean of the ILEC and CLEC observations.
Calculate the Adjusted Modified z 1 test statistics

$$z = \frac{\bar{x}_{1w} - \bar{x}_2}{s_{1w}\sqrt{c_1 + \frac{1}{n_2}}},$$

where

$$\bar{x}_{1w} = \frac{\sum_j \left(w_{1j}^1 \sum_{i=1}^{n_{1j}^1} x_{1ij}^1 + w_{1j}^2 \sum_{i=1}^{n_{1j}^2} x_{1ij}^2\right)}{n_2}, \quad w_{1j}^1 = \frac{n_{2j}^1}{n_{1j}^1}, \quad w_{1j}^2 = \frac{n_{2j}^2}{n_{1j}^2},$$

$$s_{1w}^2 = \frac{\sum_j \left(w_{1j}^1 \sum_{i=1}^{n_{1j}^1} (x_{1ij}^1 - \bar{x}_{1w})^2 + w_{1j}^2 \sum_{i=1}^{n_{1j}^2} (x_{1ij}^2 - \bar{x}_{1w})^2\right)}{n_2 - 1} \text{ and}$$

$$c_1 = \frac{\sum_j [(w_{1j}^1)^2 n_{1j}^1 + (w_{1j}^2)^2 n_{1j}^2]}{(n_2)^2}.$$

Calculate the Adjusted Modified z 2 test statistics

$$z = \frac{\bar{x}_{1w} - \bar{x}_2}{s_{1w2}},$$

where

$$s_{1w2}^2 = \mathrm{var}(\bar{x}_{1w} - \bar{x}_2) = \frac{\sum_j n_{2j}^1 (w_{1j}^1 + 1) s_{1j1}^2 + n_{2j}^2 (w_{1j}^2 + 1) s_{1j2}^2}{(n_2)^2} \text{ and}$$

s_{1j1}^2 and s_{1j2}^2 are the regular standard error of ILEC observations in subclass 1 and 2 in wire center j.

8. Jackknife test statistics calculation. Sort the wire centers according to ILEC wire center sizes, group every 30 wire centers sequentially to form 8 groups, permute the

wire centers within each of the 8 groups to reduce bias, and select one wire center from each group to form a replicate. We have total 30 replicates. Calculate an estimator $\vec{B}$ from the full data set using

$$\vec{B} = \frac{\sum_j [n_{2j}^1(\bar{x}_{1j}^1 - \bar{x}_{2j}^1) + n_{2j}^2(\bar{x}_{1j}^2 - \bar{x}_{2j}^2)]}{n_2},$$

where $\bar{x}_{1j}^1$ and $\bar{x}_{1j}^2$ are the first and second subclass mean of ILEC in wire center j and $\bar{x}_{2j}^1$ and $\bar{x}_{2j}^2$ are the first and second subclass mean of CLEC in wire center j. Let $\vec{B}_{(g)}$ denote the estimator of the same functional form as $\vec{B}$ but calculated from the observations removing the g^{th} replicate. Define the g^{th} pseudo-value as

$$\vec{B}_g = 30 \cdot \vec{B} - 29 \cdot \vec{B}_{(g)}.$$

There are total 30 pseudo-values. Calculate the Jackknife statistics using

$$t = \frac{\bar{\vec{B}}}{\sqrt{v(\bar{\vec{B}})}},$$

where $\bar{\vec{B}} = \frac{1}{30}\sum_{g=1}^{30} \vec{B}_g$ and $v(\bar{\vec{B}}) = \frac{1}{30(30-1)}\sum_{g=1}^{30}(\vec{B}_g - \bar{\vec{B}})^2$. Calculate the adjusted Jackknife 1 test statistics using

$$t = \frac{\bar{\vec{B}}}{\sqrt{v(\bar{\vec{B}})}} * \frac{\sqrt{c_1 s_{1w}^2 + \frac{s_2^2}{n_2}}}{s_{1w}\sqrt{c_1 + \frac{1}{n_2}}},$$

where s_2 is the regular standard error of the CLEC observations. Compute the adjusted Jackknife 2 test statistics as follows.

$$t = \frac{\bar{\vec{B}}}{\sqrt{v(\bar{\vec{B}})}} * \sqrt{\frac{\sum_j [(w_{1j}^1)^2 n_{1j}^1 s_{1j1}^2 + (w_{1j}^2)^2 n_{1j}^2 s_{1j2}^2] + \sum_j [n_{2j}^1 s_{2j1}^2 + n_{2j}^2 s_{2j2}^2]}{\sum_j [n_{2j}^1 (w_{1j}^1 + 1) s_{1j1}^2 + n_{2j}^2 (w_{1j}^2 + 1) s_{1j2}^2]}},$$

where s_{2j1} and s_{2j2} are the sample variances of CLEC observations in subclass 1 and 2 in wire center j, respectively.

9. Compare all the test statistics with the critical value -1.65.

Repeat the above procedure 1000 times to estimate the type I or type II error of the corresponding test.

Follow-on Statistical Analysis
Of
BellSouth Telecommunications, Inc.
Performance Measure Data

Percent Flow-Through Performance Measure

Summary
The data is not currently available to perform a statistical analysis of this process. BellSouth has data on the CLEC process; however, the BellSouth Retail flow-through report is taken from an application program which produces the Service Order Flow Tracking and Evaluation Report (SOFTER). BellSouth is still investigating how to produce the underlying data from this system, which was not designed to provide the necessary comparative information.